

AMENDMENT**Attorney Docket No. Case 7073****Patent Application Serial No. 10/802,474****Reply to Office Action mailed July 19, 2006****Art Unit 3749****Confirmation No. 5322****Page 5****Remarks/Arguments:**

The Examiner's Office Action mailed July 19, 2006 has been carefully reviewed. Reconsideration of this application in view of the above amendments and the following remarks is respectfully requested.

Claims 1 and 7 have been amended to more particularly and clearly define the Applicant's invention. Claims 2-6 and 8-12 were previously presented and remain in this application along with amended claims 1 and 7.

We turn now to a discussion of the factors which created a need for Applicant's invention, and to the remedy provided by his invention.

The accumulation of fireside deposits on the tubular heat exchange surfaces of boilers decreases their thermal conductivity and the boiler efficiency. To completely eliminate the negative effects of fireside deposits on boiler efficiency, the tubular heat exchange surfaces would essentially need to be free of such deposits. These deposits are removed by directing a cleaning medium such as air, steam, water or mixtures thereof, against the surfaces upon which the deposits accumulate with cleaning devices known in the art as sootblowers. However, the continuous cleaning that would be required to maintain this cleanliness would be prohibitively expensive and prematurely damage the tubular heat exchange surfaces. These surfaces can be damaged as a result of erosion by high velocity air or steam jets and/or thermal impact occurring by impinging a jet of relatively cool cleaning medium, especially air or liquid onto a hot surface. Thus, physical deterioration of the tubular heat exchange surfaces may occur where the tubes are over-cleaned in this manner. Such degradation of the tubular heat exchange surfaces of a boiler can produce catastrophic failures and a significant financial loss for the boiler operator.

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Accordingly, sootblowers are normally operated on a time schedule based on past experience on measured boiler conditions, in particular the reduction of heat transfer by tubular heat exchange surfaces. Boiler conditions may be determined by visual observation, by measuring boiler parameters, or by the use of sensors on the tubular heat exchange surfaces to measure conditions indicative of the level of deposits accumulation.

Typically, the sootblowers are permanently installed between rigidly held tube banks such as those made up of pendant boiler tubes found in large scale boilers. Since the pendant tubes are rigidly held, they cannot distort in response to the temperature induced shrinkage and expansion occurring during the cleaning cycle. Difficulties are also present in an effort to produce adequate cleaning performance while avoiding thermal overstressing since the heat exchanger tube surfaces to be cleaned are of varying distance from the lance tube nozzle and, therefore, a varying speed of blowing medium jet progression across the heat exchanger surface occurs. Areas of slow progression may receive excessive quantities of sootblowing medium as compared to the amount required for effective cleaning.

Generally, a sootblower includes a retractable elongated lance tube that is regularly advanced and withdrawn through the wall of the boiler and is simultaneously rotated to position the end of the lance tube adjacent a bank of heat exchanger tubes to be cleaned. The end of the lance tube is provided with one or more nozzles which are used to project a pressurized stream of blowing medium such as steam, air or water at high velocity against the heat exchanger tubes to dislodge and clean away the soot, ash, and slag deposits. The blowing medium produces mechanical and thermal shock which causes these adhering layers of soot, ash, and slag to fall away from the heat exchange surfaces. One major advantage of cleaning boilers with sootblowers is that the boilers do not need to be shut down in order to accomplish regular cleaning of the fireside heat exchange surfaces, because cleaning is carried out while the boiler is in operation. At the conclusion of the

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cleaning cycle, the lance tube is retracted and withdrawn from the boiler to avoid exposure to the intense heat generated by the combustion of the fuel which would distort and eventually destroy the lance tube.

As noted above, boiler tubes whose outer surfaces are subjected to impact by the high velocity and abrasive blowing medium suffer from erosion and wear. Accordingly, protective devices in the form of tube shields are provided to prevent direct impingement of the outer surfaces of the boiler tubes by the sootblower blowing medium while allowing the tubes to be cleaned of soot, ash, slag, and other fouling deposits. Each shield is normally comprised of an axially elongated member of arcuate cross section sized to fit over the outer surface of the boiler tube to protect the portion of the tube which is impacted by the cleaning medium.

The tube shields work well in protecting the outer surface of the boiler tubes from the high velocity and abrasive blowing medium, but a problem arises when they are used with vertically elongated boiler tubes, such as those forming pendant tubular heat exchange surfaces, located in the boiler furnace and convection pass, and referred to in the industry as superheaters and reheaters. The pendant loops of these tubular heat exchange surfaces support themselves in simple tension and are subjected to stresses due to the differences in expansion between the different loops since their average temperatures are different because the fluid is being heated as it flows from the inlet to the outlet of the individual tubes. Therefore, it is necessary to provide split ring castings to maintain the pendant boiler tubes in parallel alignment and spaced with respect to each other. Protective tube shields are generally located immediately above and below the split ring casting. However, a serious problem has been encountered due to the difference in thermal expansion of the tube shields relative to the boiler tubes at high boiler operating temperatures, which has resulted in gaps being formed between the tube shields and the

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split ring casting thereby exposing a portion of the outer surface of the boiler tubes to the abrasive impact of the high velocity sootblower cleaning medium.

Experience has shown that the gap existing between the adjacent end faces of the boiler tube shield and the split ring casting is one of the most vulnerable areas to sootblower erosion due to flow disturbances created around the split ring casting. However, efforts at structurally bringing these end faces together and eliminating any gaps therebetween have met with failure due to the difference in thermal expansion of the boiler tube shield relative to the protected boiler tube at high boiler operating temperatures.

The present invention is directed to solving the aforementioned problem by providing split ring casting halves and a retainer shield which are sized to overlap adjacent portions of the upper and lower protective shields, thereby covering any gaps that may occur between the protective tube shields and the split ring casting resulting from the difference in the rates of thermal expansion of the boiler tubes and the tube shields at high boiler operating temperatures.

Claims 1-12 were rejected under 35 U.S.C. 103(a) as being unpatentable over **Harth et al. (6,006,702)** in view of **Green (5,724,923)**. **Harth et al.** is said to disclose a rigid structure of two halves (14, 16) of arcuate grooves such that when the two halves are mated, parallel and spaced apertures are formed to hold a series of tubes (18) in an aligned and fixed relationship. However, **Harth et al.** is also noted not to include tube shields around the tubes. **Green** is said to teach the application of mortar M to the tube which is then said to be covered by half-shields which is, in turn, said to be commensurate with the Applicant's two halves or retainer shield. Additionally, it is said with reference to claim 3, that **Green** includes clamping means, as seen at Figures 4 & 5. It is further said that the retainer shield (30) would encase the two halves including the mortar thereby enveloping any gaps. It is stated that it would have been obvious at the time that the

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invention was made to a person of ordinary skill in the art to which the subject matter pertains to have modified the invention of **Harth et al.** by providing mortar as taught by **Green** to the tubes of **Harth et al.** for the purpose of offering protection to the tubes against environmental attack and the clamping configuration as taught by **Green** for the purpose of securing the two halves around each tube.

Claims 1 and 7 have been amended. These amended claims and the previously presented dependent claims 2-6 and 8-12 are respectfully believed to patentably distinguish **Harth et al.** and **Green** taken separately or in combination with one another.

Applicant respectfully submits that **Harth et al.** relates in general to split ring castings for maintaining boiler tubes in an aligned and predetermined spaced configuration, and more particularly to a split casting (12) design which does not experience failed weld joints when subjected to a high temperature environment. Failure of the split ring casting causes misalignment of the boiler tubes (18). Replacement of the split ring casting is expensive and time consuming since the failed casting must be removed and then realigned in the new casting. **Harth et al.** is directed to solving the aforementioned high temperature problem by providing a retainer heat shield (23) preferably made of a higher temperature resistant alloy than the material of the split casting. The retainer heat shield is located at the front of the split ring casting so as to shield the weld (22) from the high temperature environment. Thus, it is noted that the **Harth et al.** invention is that of a retainer shield to protect the weld on the front of the split ring casting from the heated gas flow.

Green relates in general to refractory ceramic shields used to protect tubes from the products of combustion. These shields are comprised of two half-shields which are assembled by applying mortar to the tube or the inner surfaces of the half-shields and held together by an interlocking tongue and groove feature. The prior art drawbacks addressed

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by **Green** is the need for a clamping mechanism to hold the tongue and groove shields together until the mortar bonds the shields to the tube, and the fact that these shields have been known to fall off the tube under extreme service conditions. **Green** believes that the weakness of this prior art design stems from its reliance on the mortar layer exerting enough pressure on the shields to activate the tongue and groove mechanism. **Green** believes, in particular, that the mortar could dry and shrink in use, thus creating a space between the tube and the inter-locked half-shields and that, under extreme circumstances, the inter-locked half shields could radially shift relative to each other, unlock and ultimately fall from the tube when exposed to the high velocity flow of combustion gases through the boiler. **Green's** invention is said to solve the problem of the tongue-and-groove design by providing a lock independent of the mortar's ability to provide a tight fit between the half-shields.

Applicant respectfully submits that **Green** is directed at a refractory shield comprised of first and second-partial tubes, each partial-tube having a C-shaped cross section, the C-shaped section defining first and second ends; wherein the ends of the first partial-tube oppose the ends of the second partial-tube, and wherein the partial-tubes comprise means for preventing radial movement of the first partial tube relative to the second partial-tube.

Turning now to that which **Green** characterizes as an especially preferred embodiment, as shown in FIG. 2, there is provided a refractory shield (1) for protecting a superheater tube (S) against environmental attack, comprising a first partial-tube (2) having a C-shaped cross section, the C-section having first and second ends (3) and (4), each end comprising an outer radial portion (5) and an inner radial portion (6), each radial outer portion extending in a concave arc of at least 10° farther than each inner radial portion to define a seat 7 at the terminus of each inner radial portion, each outer radial portion terminating in a tip (12). A second partial-tube (8) having a C-shaped cross section, the C-shaped cross section terminating in first and second tips (9) and (10); wherein the tips of

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the second partial-tube oppose the seats of the first partial-tube, and the distance "b" between the tips of the second partial-tube is greater than the distance "a" between the tips of the first partial-tube. The embodiment shown in FIG. 2 is said to prevent the second partial-tube from radially shifting, i.e., falling off, by requiring the distance between the tips of the second-partial tube to be greater than the distance between the tips of the first partial tube.

The alternate embodiments shown in FIGS. 3-6 of **Green** disclose different partial-tube locking features said to provide different advantages in different heat exchange designs; however, each is said to nonetheless include the commonality of a means for preventing the relative radial movement of one partial-tube vis-à-vis its opposing partial-tube.

Green states that *"For the purpose of [his] present invention, "radial movement is considered to be perpendicular movement toward or away from the surface of the superheater tube which results in disengagement of the half-shields."* (emphasis added) (See: column 2, lines 28-31).

Green also states that *"the scope of [his] invention comprises superheater tube shield designs which preclude radial movement of the partial-tubes without relying on either mortar or clamps"* (emphasis added) (See: column 4, lines 34-38).

Applicant respectfully sees **Green** as looking for a solution to the problem of half shields falling off the tubes as a result of extreme service conditions. The **Green** invention is said to solve this problem by circumferentially extending the ends of one of the mating half shields so as to partially wrap around the other of the mating half shield and thus prevent the disengagement of the mated half shields. While this may prove to be a solution to the problem of falling half shields faced by **Green**, it neither addresses nor provides a solution to the problem faced by Applicant which is the exposure of boiler tube surfaces to the erosive impact of the sootblowing medium due to the difference in thermal

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expansion of the boiler tube shield relative to the protected boiler tube at high boiler operating temperatures.

Applicant respectfully submits that his invention is one which addresses a problem of longitudinal expansion, that is to say, lengthwise growth of the boiler tube as opposed to the problem of radial or transverse movement toward or away from the tube addressed by **Green**.

Green believes that the interlocked refractory ceramic half-shields that cloak the tube fall off because the mortar which bonds the half-shields to the tube dries and shrinks in use, creating a space the tube and the interlocked half-shields. According to **Green**, under extreme circumstances, the interlocked half-shields can radially shift relative to each other, unlock and ultimately fall from the tube when exposed to the high speed gases of the boiler. **Green** is said to provide a locking mechanism for the half-shields that is independent of the mortar's ability to provide a tight fit between its half-shields.

As noted above, the preferred and alternate embodiments disclosed by **Green** share the commonality of a means for preventing the relative radial movement of one half-shield vis-à-vis its opposing half-shield. The purpose of **Green's** locking mechanism is to stop the movement of the half-shields so as to provide a secure bond therebetween.

It is respectfully submitted that one of ordinary skill in the art would not be looking to **Green** for guidance since preventing movement of the half shields as taught by **Green** would prove detrimental to Applicant's structure which must accommodate longitudinal movement or growth resulting from thermal expansion of the tube shields and the tubes. It should be noted that **Green** is particularly concerned with the mortar layer which was expected to bond the half-shields to the tube while also exerting enough pressure on the shields to activate the tongue-and-groove locking mechanism. However, **Green** believes that the mortar could dry and shrink in use, creating a space between the tube and the interlocked half-shields. **Green** notes that, under extreme circumstances, the interlocked

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half-shields could radially shift relative to each other, unlock and ultimately fall from the tube when exposed to the high speed gases of the boiler. **Green** is said to solve the problem faced by the tongue-and-groove design by providing a lock independent of the mortar's ability to provide a tight fit between the half-shields and which is said to preclude radial movement of the half-shields.

Applicant respectfully submits that his is a welded structure which does not require an interlocking tongue-and-groove mechanism to prevent the shields from moving and falling off the protected tubes. On the contrary, Applicant's tube and shield structure undergoes movement in the form of thermal expansion as a result of high temperatures experienced during operation of the boiler. If Applicant's structure were prevented from thermally expanding it would give rise to stresses that could eventually lead to failure of the structure.

Accordingly, it is respectfully submitted that **Harth et al.** and **Green** are concerned with entirely different problems than that of Applicant, and consequently disclose different inventions to solve their respective problems. **Harth et al.** is concerned with the problem of failing welds on a split ring casting due to a high temperature environment or heat front, and solves this problem by providing a heat shield. **Green** is concerned with the problem of half-shields falling off the tubes due to failure of the mortar which is said to insure a tight fit between the half-shields and the tubes, and solves this problem by providing a locking mechanism independent of the mortar's ability to insure a tight fit while preventing or restricting the movement of the half-shields. Applicant's problem, on the other hand, is one of tube exposure due to gaps created between the split ring casting halves and the tube shields as a result of thermal expansion of the tube and the tube shield structure, and the need to cover such gaps while accommodating the movement caused by thermal expansion of the tube and tube shield structure. Thus it is not believed that one of ordinary

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skill in the art would be motivated to look to **Harth et al.**'s failing weld problem, or **Green's** failing half-shield problem for a solution to the tube exposure problem faced by Applicant.

Applicant respectfully submits that claims 1-12, as presented, are thus patentably distinct and nonobvious over **Harth et al.** and **Green**, taken separately or in combination.

Applicant has endeavored to make the foregoing response sufficiently complete to permit prompt, favorable action on the subject patent application. In the event that the Examiner believes, after consideration of this response, that the prosecution of the subject patent application would be expedited by an interview with an authorized representative of the Applicant; the Examiner is invited to contact the undersigned at (330) 860-6605.

Respectfully submitted,

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